

INTEGRATION OF ABANDONED MINE RECLAMATION AT MULTIPLE SITES WITH LEACH PAD RECLAMATION AT THE BASIN CREEK MINE IN MONTANA¹

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Abstract. The Montana Department of Environmental Quality took over management and closure responsibility of the Basin Creek Mine in 2003 after bankruptcy of Pegasus Gold Corporation. Leach pad one (LP-1) at the site is a 26 acre cyanide heap leach facility that was reclaimed by the former mine owner with a soil cover. To reduce the costs associated with management and treatment of up to 12,000,000 gallons per year of cyanide contaminated leachate generated by leach pad LP-1, a cap composed of geosynthetic clay liner, geocomposite drainage layer, and vegetated soil cover is being constructed. Reclamation of three nearby abandoned mines is being coordinated to enable over 70,000 cubic yards (cy) of mine waste to be relocated to leach pad LP-1 and placed beneath the cap. Consolidation of wastes within one location provides significant economic savings over construction of separate waste repositories.

Additional Key Words: waste rock, tailings, cap, cyanide, geosynthetic clay liner

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Introduction

Consolidation of mine wastes from adjacent abandoned mine sites and placement into a single mine waste repository has numerous advantages over constructing separate waste repositories at each of the sites. Reconstruction of the leach pad one (LP-1) cap at the Basin Creek Mine (Figure 1) provided an opportunity to consolidate wastes from three nearby mine sites into a single location. In 2004, the Montana Department of Environmental Quality (DEQ) decided to construct an impermeable cap on LP-1 in an effort to reduce the amount and cost of leachate treatment. Up to 12,000,000 gallons per year of cyanide contaminated leachate was generated by leach pad LP-1. DEQ identified three nearby mine sites where on-site reclamation was being considered during its evaluation of leach pad LP-1 cap conceptual design (Tetra Tech, 2004a). The three sites included the Ontario Mine and Mill site (approximately four miles west of leach pad LP-1), the Argentine Mine site (approximately eight miles east of leach pad LP-1) and the Blue Bird Mine site (approximately twelve miles east of leach pad LP-1). Reclamation of each of these mine sites posed technical problems due to lack of suitable areas for construction of waste repositories. In 2005, DEQ decided to relocate mine wastes from the Ontario and Argentine mine sites to leach pad LP-1 and in 2006 decided to relocate wastes from the Blue Bird Mine site to leach pad LP-1. DEQ has contracted with Tetra Tech EM Inc. (Tetra Tech) of Helena, Montana for reclamation investigation, engineering, and construction oversight assistance on this project. Relocation of wastes from these sites and construction of the leach pad LP-1 cap is expected to be completed by the fall of 2006.

Site Descriptions

Basin Creek Mine Site

The Basin Creek Mine site (BCMS) is an inactive open-pit gold mine located at an elevation of over 7,000 feet above sea level approximately 17 miles southwest of Helena, Montana. BCMS is located within the Upper Tenmile Creek Mining Area National Priorities List (NPL) site and the Basin Mining Area NPL site. BCMS was operated historically as an open-pit heap leach facility. Approximately 3,000,000 tons of ore were mined during its operation. Two cyanide heap leach pads were developed and are now closed. Three open pits were developed and two pits were backfilled. One open pit remains (Luttrell Repository) and is being used by the U.S. Environmental Protection Agency (EPA) as a mine waste repository for Superfund remedial activities within the two NPL sites.

BCMS was operated by the Basin Creek Mining, Inc. (BCMI), owned by Pegasus Mining Company, before its bankruptcy in June 1998. Between December 1998 and March 2003, a bankruptcy trustee conducted reclamation activities at the site. In April 2003, the bankruptcy case was closed and the

BCMS property was transferred to the State of Montana. Since April 2003, the DEQ has been managing the BCMS and conducting closure activities. These yearly activities have included (1) removing inactive and unneeded facilities and infrastructure; (2) managing stormwater systems; and (3) collecting and treating leach pad LP 1 leachate discharge. In July 2005, DEQ began construction of an impermeable cap on leach pad LP-1. Construction of the leach pad LP-1 cap is expected to be completed by October 2006.



Figure 1: Leach Pad One at Basin Creek Mine Site

Ontario Mine and Mill Site

The Ontario Mine and Mill site (Figure 2) are abandoned inactive mining facilities located approximately 10 miles south of Elliston, Montana. Prior to reclamation in 2005, the Ontario Mine and Mill site included waste rock dumps, a collapsed mill building, and tailings piles. The site was investigated and evaluated for reclamation options in an expanded engineering evaluation and cost analysis (EEE/CA) completed by Maxim Technologies under a contract with the U.S. Forest Service (USFS) (Maxim, 2001). Portions of the site located entirely on USFS lands were reclaimed by the USFS in 2003. Reclamation of the remaining portions of the site located on mostly private lands, was to be addressed by DEQ. However, reclamation options were limited. The feasibility of constructing an on-site waste repository was limited due to steep terrain and land availability. In-place consolidation and capping were feasible, but a less effective alternative than either an on-site waste repository or off-site disposal.



Figure 2: Waste Rock Dump at Ontario Mine and Mill site

Argentine Mine Site

The Argentine Mine site (Figure 3) is an abandoned hardrock lead and silver mine listed on the Montana DEQ/Mine Waste Cleanup Bureau (MWCB) priorities sites list. The Argentine Mine site is located twelve miles west of Wickes, Montana, in the Colorado Mining District, Jefferson County, Montana. The mine site is situated at an elevation of 7,400 feet above sea level and consists of approximately 2.6 acres of disturbed lands. The site contains mine structures, mine openings, and waste rock that have been deposited in the South Fork Quartz Creek drainage. An EEE/CA completed in 2004 (Tetra Tech, 2004b) identified (1) an open pit and waste rock pile containing approximately 4,000 cubic yards (cy) of waste rock; (2) a side cut into the mountain and open adit with a waste rock dump containing approximately 50 cy of waste rock; (3) a side cut into the mountain and collapsed adit with a waste rock dump containing approximately 900 cy of waste rock; and (4) a trench and a bench made of trench spoil with approximately 1,300 cy of waste rock. The EEE/CA identified excavation and consolidation of mine waste in an on-site repository as the preferred alternative.



Figure 3: Waste Rock and Adit Drainage at Argentine Mine

Blue Bird Mine Site

The Blue Bird Mine site (Figure 4) is an abandoned hardrock gold and silver mine listed on the Montana DEQ/MWCB priorities sites list. The Blue Bird Mine site is located approximately four miles west of Wickes, Montana, in the Colorado Mining District, Jefferson County, Montana. The mine site is situated at an elevation of 7,000 feet above sea level and consists of approximately four acres of disturbed lands. The site contains mine structures, mine openings, and waste rock within the upper reaches of the Curtain Creek drainage. The EEE/CA completed for the site (Tetra Tech, 2003) identified (1) an upper waste rock dump containing between 40,000 and 50,000 cy of waste rock; (2) a lower waste rock dump containing between 5,000 and 10,000 cy of waste rock; (3) four small satellite waste rock dumps containing between 1,500 and 2,000 cy of mine waste; and (4) between 2,000 and 5,000 cy of in-stream sediment. The preferred alternative identified in the EEE/CA was off-site disposal at a mine waste repository. On-site construction of a repository was considered infeasible due to steep terrain and limited available land.



Figure 4: Upper Waste Rock Dump at Blue Bird Mine

Combined Site Reclamation

DEQ considered a number of factors when deciding to integrate the leach pad LP-1, Ontario, Argentine, and Blue Bird reclamation projects. First, DEQ's preferred reclamation alternative (disposal in an on-site repository) was impractical at the Ontario and Blue Bird Mine sites due to steep terrain and lack of available land to site a repository. Physical site constraints and steep slopes also made implementing an on-site repository difficult at the Argentine Mine site. Other in-place reclamation alternatives including in-place capping were less desirable primarily because these alternatives provide less long-term protectiveness than disposal in a repository with little reduction in cost.

A second factor considered by DEQ was that leach pad LP-1 capping costs were not affected by placement of additional wastes at leach pad LP-1. The amount of waste from the Ontario (12,641 cy), Argentine (1,856 cy), and Blue Bird (40,000 cy) sites was small compared to the 3,000,000 tons of ore in place at leach pad LP-1 and the placement of these additional wastes would not alter the overall area of the proposed leach pad LP-1 cap. In addition, since leach pad LP-1 had an existing bottom liner, the cost of constructing a repository bottom liner was avoided.

Long-term maintenance at the reclaimed sites was also a consideration. Removal of wastes from the mine sites would provide greater long-term protectiveness than leaving wastes on site. In addition, maintenance costs of four

waste repository sites would be significantly greater than maintenance of only one site.

Reclamation Design

In spring 2005 Tetra Tech completed the engineering design and bid package for reclamation construction at leach pad LP-1 and the Ontario and Argentine mine sites. In spring 2006 Tetra Tech completed engineering design of Blue Bird Mine reclamation. The locations of the three sites are shown on Figure 5. The principle reclamation components for each site are summarized below.

Leach Pad LP-1 Design

The work at leach pad LP-1 at the Basin Creek Mine consists of constructing temporary and permanent storm water controls; constructing temporary access roads; improving, maintaining and realigning existing access roads; clearing and grubbing the work site; excavating and temporarily stockpiling surface soil, drainage ditch rock, and subsoil; placing, grading and compacting waste received from the Ontario, Argentine and Blue Bird mines; regrading leach pad LP-1; constructing a multi-layer cap over leach pad LP-1 using geosynthetic clay liner and a geocomposite drainage layer; constructing interception trenches for surface water runoff; revegetating the disturbed areas and cap; and consolidating and disposing of miscellaneous solid waste off site.

Ontario Mine and Mill Site

The work at the Ontario Mine and Mill site consists of constructing temporary and permanent storm water controls; constructing short access roads; improving existing access roads; clearing and grubbing the work site; removing the upper waste rock dump located at the Ontario Mine; demolishing and removing structures and debris and constructing an adit discharge diversion channel. Mine waste removal consists of excavating and hauling 12,641 cy of waste rock approximately three miles over existing roads to leach pad LP-1 at BCMS. After waste removal the excavated area is regraded to match surrounding topography prior to being revegetated. The adit discharge channel construction consists of about 500 feet of riprap channel from the upper adit discharge to an existing drainage downslope of the upper waste rock dump. All disturbed areas are regraded and revegetated.

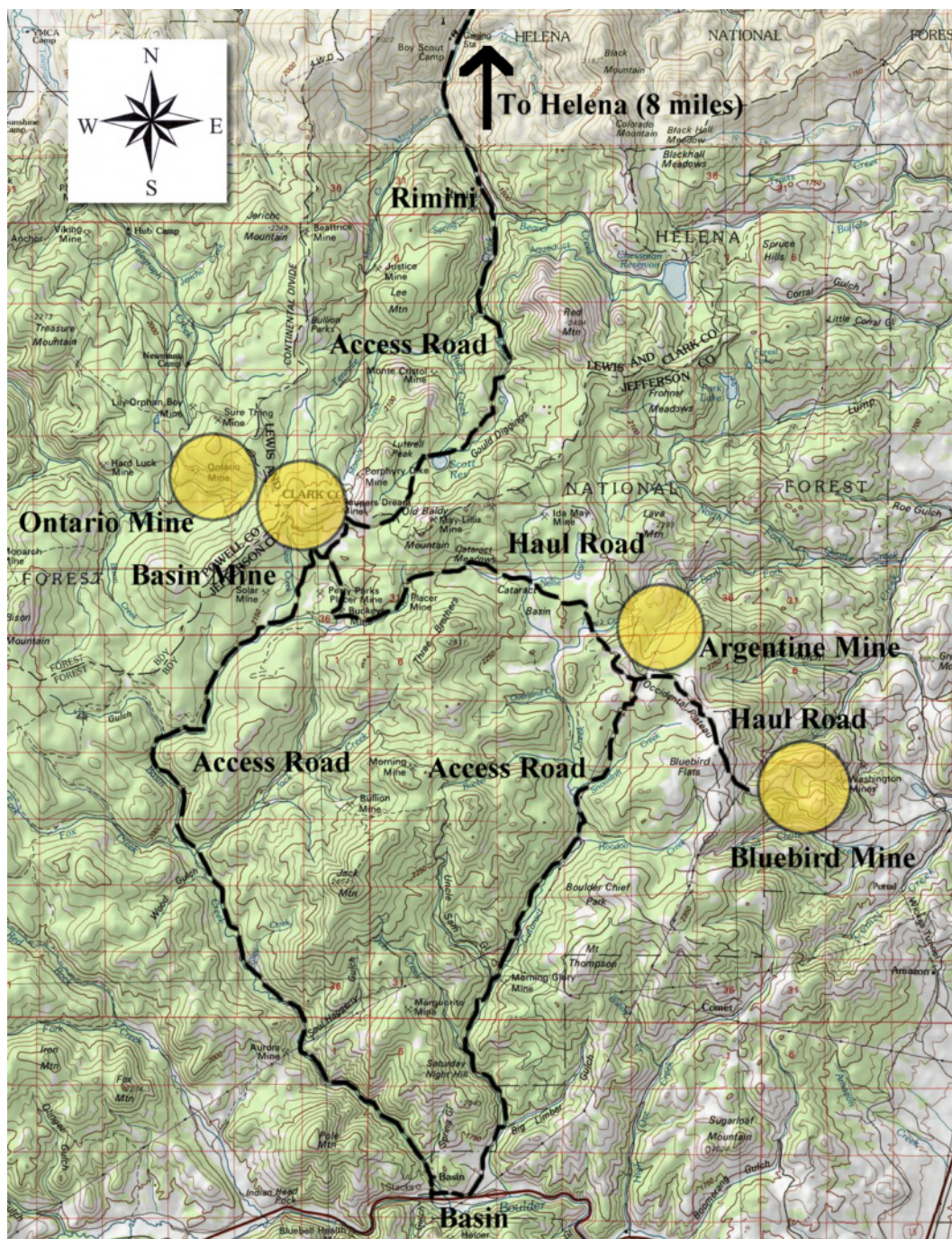


Figure 5: Site Location Map

Argentine Mine Site

The work at the Argentine Mine consists of constructing temporary and permanent storm water controls; constructing short access roads; improving existing access roads; clearing and grubbing the work site; excavating and hauling 1,856 cy of mine wastes approximately eight miles over existing roads to leach pad LP-1 at the BCMS; reconstructing surface water drainages; grading disturbed areas; excavating, hauling, and placing cover soil from an on-site source; revegetating disturbed areas and consolidating and disposing miscellaneous solid waste off site.

Blue Bird Mine Site

The reclamation project plan at the Blue Bird Mine consists of two phases of work and includes the excavation, removal and relocation of the upper waste rock dump (UWRD) and the excavation, relocation, and regrading of the lower waste rock dumps (LWRD). Phase 1 work consists of improving existing access roads; constructing new access roads; clearing and grubbing; constructing a stream and adit water bypass; excavating and hauling 40,000 cy of mine wastes approximately twelve miles over existing roads; placing and compacting waste rock at leach pad LP-1; backhauling and stockpiling approximately 8,000 cy of cover soil from the BCMS to the Blue Bird Mine; and disposing of miscellaneous debris off site. Phase 2 work consists of excavating, relocating, and regrading approximately 2,500 cy of waste rock at the LWRD; constructing adit drains; constructing a new stream channel; backfilling select areas; recontouring, placing cover soil, and revegetating disturbed areas; constructing runon and runoff diversion ditches; constructing farm fence around the Blue Bird Mine site; obliterating and reclaiming all temporary haul or access roads; and disposing of miscellaneous debris off site.

Cost Comparison

Tetra Tech conducted a cost comparison of on-site disposal costs to placement costs at leach pad LP-1. The comparison is summarized in Table 1. On-site disposal costs were estimated from historic cost data for other sites and assumed that a suitable repository site could be located at each mine. Potential costs for land acquisition were not considered. Haul and placement costs at leach pad LP-1 were based on construction bids received for this work. The analysis showed that waste placement at leach pad LP-1 was less expensive than on-site disposal and could result in a potential cost savings of about \$549,000.00.

Table 1: Comparison of On-Site Disposal Costs to Disposal Costs at Leach Pad LP-1

Site	Waste Volume (cy)	On-Site Disposal Unit Cost (\$/cy) ^{1,2}	On-Site Construction Disposal Cost (\$)	LP-1 Round Trip Haul Distance (miles)	Haul and Placement at LP-1 Unit Cost (\$/cy) ³	Haul and Placement in LP-1 Cost (\$)	Potential Avoided Cost (\$)
Ontario	12,641	\$ 38.11	\$ 481,730.12	8	\$ 11.90	\$ 150,383.66	\$ 331,346.46
Argentine	1,856	\$ 57.31	\$ 106,372.83	16	\$ 17.77	\$ 32,976.48	\$ 73,396.35
Bluebird	40,000	\$ 26.58	\$1,063,107.45	24	\$ 22.97	\$ 918,800.00	\$ 144,307.45

Notes:

1. All on-site unit costs based on construction costs. Engineering costs not included. All costs adjusted to 2006.
2. Unit cost of on-site disposal in a lined repository based on historic costs for other DEQ reclamation sites.
3. Unit costs for Argentine, Ontario, and Blue Bird placement at leach pad LP-1 based on construction bids.
4. Leach pad LP-1 cap costs would not be significantly altered by placement of additional materials.

\$ = dollars

cy = cubic yards

\$/cy = dollars per cubic yard

LP-1 = leach pad LP-1

Risk and Avoided Costs

Consolidating mine waste at a single repository results in savings in monitoring and maintenance costs and fencing and operational facilities, such as leachate collection systems and run-on/run-off storm water controls. These costs are associated with most mine waste repository sites. Monitoring and maintenance costs in Montana average approximately \$3,300.00 per site over an average 3 year monitoring period. The construction costs associated with leachate collection systems, fencing and storm-water control on average are \$13, 400.00 per site. For the Ontario, Argentine and Blue Bird mine sites, avoiding these costs results in a savings of about \$50,100.00.

Avoided land acquisition is another cost consideration that can, in the appropriate situation, be a substantial cost savings. The availability of a suitable site is often a problem in mine sites in Montana's mountainous areas, as was the case for the decision to consolidate the three abandoned mines' waste at the leach pad LP-1 site. This cost would be somewhat offset by the increase in hauling to a central repository.

The risk, or liability, of three repository sites as compared to one consolidated waste repository has a potential cost which is a little intractable to estimate. While this cost is much harder to calculate as a hard dollar and cents cost, it was not ignored in the decision to consolidate mine waste at these sites.

A failure in the performance of a repository seldom occurs, but the chance that one of three such repositories failing is higher than a single repository. A failure of a repository can involve substantial rebuild to remedy the failure and the cost could be almost as expensive as the original construction cost, \$250,000.00 or more. The risk just discussed does not take into account the even harder question of the environmental liability associated with a repository failure such as surface water or groundwater impacts.

Consolidating mine wastes into one repository reduces the effort in monitoring and maintenance and combines and thereby reduces the cost of repository facilities and improves management of the mine waste.

Reclamation Construction

Project construction began in July 2005. Initial work included stripping approximately 90,000 cy of cover soil and subsoil from leach pad LP-1 and stockpiling the soil for later use in the leach pad LP-1 cap. After soil stripping was completed, regrading of leach pad LP-1 was conducted to reduce slopes and prepare areas for waste placement. Wastes from the Ontario Mine site were hauled and placed in leach pad LP-1 by September 2005. In October 2005 reclamation of the Ontario Mine site was completed and the leach pad LP-1 project site was secured for winter shutdown. In June 2006, cap construction began on leach pad LP-1 and in July 2006 waste removal and hauling began at the Argentine and Blue Bird mine sites. All waste hauling is expected to be completed by September 2006. All other reclamation activities at leach pad LP-1, Blue Bird, and Argentine mine sites are expected to be completed by October 2006.

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